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THE ATCHISON DIAMOND-DRILL PROSPECT HOLE.

BY A. E. LANGWORTHY, ATCHISON.

Read before the Academy, at Topeka, December 28, 1900.

In the spring of 1899, Mr. Chas. Crawford, a coal dealer of Atchison, mentioned to Mr. S. C. King, of the executive committee of the committee of forty, that Mr. J. E. Carr was about to retire from the management of the North Leavenworth Coal Company, and incidentally told Mr. King that Mr. Carr believed the same seam of coal existed under Atchison as that mined at Leavenworth.

Mr. King wrote Mr. Carr inviting him to come to Atchison and look over the situation. Mr. Carr and his son did so and gave it as their opinion that coal existed; but they expressed a wish to see the records of the prospect holes which had been drilled in and about the city. When the writer learned of this desire on the part of the Messrs. Carr he at once placed at their disposal copies of such university reports and transactions of this Academy as he had.

The writer then became interested in the matter himself and began looking up records which did not appear in those publications. He also began studying the geological formation near Atchison, making numerous trips to various points where there were outcroppings of coal or rock. On one of these trips, in company with Prof. E. B. Knerr, of Midland College, especially valuable information was obtained.

In looking up records much assistance was given by Mr. M. Noll, a pharmacist of Atchison, who furnished several records as well as a chart of a diamond-drill prospect hole at Valley Falls, Kan., about twenty miles southwest of Atchison. This chart was plainly the work of Prof. E. B. Knerr, since the initials "E. B. K." appear in one corner. As neither this chart nor a record of the prospecting at Valley Falls has, to the knowledge of the writer, ever been published, the description accompanying the chart is quoted in full, in connection with this paper.

RECORD of diamond-drill hole at Valley Falls, Kan., drilled in 1888, by Ingells Bros., of Atchison, Kan. First column of figures shows thickness of strata, in feet; second column shows total depth of hole, in feet.

Soil.....	8	8	Shale.....	7	391
Gravel.....	9	17	Gray sandstone.....	15	406
Shale.....	17	34	White sandstone.....	9	415
Gravel.....	3	37	Yellow sandstone.....	2	417
Sandstone.....	3	40	Dark sandstone.....	40	457
"Granite" rock.....	16	56	Shale.....	1	458
White limestone.....	12	68	Light sandstone.....	34	492
Shale.....	22	90	Shale, changing to limestone mixed with flint.....	6	498
Limestone.....	15	105	Dark shale.....	2	500
"Magnesia".....	3	108	Hard limestone.....	3	503
Limestone.....	12	120	Dark shale.....	1	504
Blue shale.....	5	125	Limestone.....	2	506
Limestone.....	10	135	Dark, soft limestone.....	4	510
Shale.....	40	175	Soft, white limestone.....	3	513
Limestone.....	4	179	Limestone.....	13	531
Sandstone.....	8	187	Shale.....	9	540
Shale and limestone mixed.....	11	198	Hard limestone, with irregular streaks.....	23	563
Shale.....	5	203	Sandstone.....	9	572
Limestone.....	22	225	Shale.....	1	573
Hard shale.....	7	232	Limestone.....	4	577
Limestone.....	10	242	Limestone with streaks of dark shale.....	10	587
Hard shale.....	19	261	"Honeycomb" stone.....	3	590
Sandy shale.....	25	286	Dark gray "granite".....	22	612
Soft, light limestone.....	7	293	Yellow rock, with gravel and shells, Shale.....	1	615
Shale.....	2	295	Hard limestone.....	3	619
Soft sandstone.....	16	311	Shale.....	3	622
Shale.....	14	325			
Shale and limestone mixed.....	15	340			
Sandstone, bearing salt water.....	42	382			
Light, soft limestone.....	2	384			

Sandstone.....	11	633	Limestone.....	9	979
Sandy soapstone.....	26	659	Dark and light shale, with shells.....	12	991
Shale.....	5	664	Dark shale.....	3	994
Sandstone.....	17	681	Coal.....	1	995
Hard limestone.....	15	696	Dark shale, changing to light.....	12	1007
Shale.....	7	703	Light shale, intermixed with lime-		
Limestone.....	13	716	stone and sandy shale (coal		
Shaly sandstone.....	22	738	marked near top of this stratum,		
Limestone.....	9	747	but thickness not given).....	20	1027
Shale.....	3	750	Light shale, intermixed with lime-		
Yellow limestone.....	10	760	stone.....	12	1039
Hard limestone.....	5	765	Dark shale.....	3	1042
Dark shale.....	4	769	Light shale.....	17	1059
Limestone.....	8	777	Light shale, mixed with limestone..	10	1069
Hard, dark shale.....	2	779	Blue shale.....	2	1071
Soft shale.....	3	782	Light shale, changing to sandstone..	11	1082
Dark shale.....	4	786	Shale.....	5	1087
Light shale.....	2	788	Blue shale, turning dark.....	3	1090
Limestone.....	18	806	Coal, four inches.....	..	1090
Dark shale.....	5	811	Dark shale, changing to light, and		
Limestone.....	3	814	running into sandstone.....	12	1102
Dark shale.....	8	822	Coal, six inches.....	..	1103
Limestone and shale.....	27	849	Shale.....	9	1112
Light shale.....	7	856	Shale mixed with limestone, chang-		
Limestone mixed.....	13	869	ing to light sandstone.....	11	1123
Sandy shale.....	5	874	Light and dark shale.....	7	1130
Soft sandstone.....	5	879	Dark sandstone.....	5	1135
Hard sandstone.....	26	905	Dark shale, with trace of coal.....	5	1140
Sandy shale.....	14	919	Sandstone.....	9	1149
Hard limestone.....	5	924	Light sandstone and shale.....	5	1154
Shelly shale.....	10	934	Light sandstone.....	7	1161
Light shale.....	10	944	Light shale and sandstone, with a		
Limestone.....	4	948	trace of coal.....	7	1168
Dark, soft shale.....	5	953			
Shale mixed with coal and lime-					
stone.....	17	970			

The result of studying the geological formation, as shown at the surface and by the various records of wells, etc., was to convince the writer that Atchison was situated over the Coal Measures. It further seemed probable that a workable seam of coal might be found, in spite of the fact that the published records at that time, especially the record of what was called the Atchison deep boring, appearing in vol. XIV, page 255, of the Transactions of this Academy, gave no indication that such a seam existed. In fact, the records, and in particular the one mentioned, as it showed no coal in a hole 1204 feet deep, gave the impression that coal would *not* be found.

The secretary of the company which drilled the well in question informed the writer, however, that his company did find coal in drilling that hole, which was made with a churn drill. This fact, in connection with the numerous stories to the effect that the correct records had been suppressed by interested parties, confirmed the writer in his belief that workable coal really existed.

A report of what had been found in regard to the geological formation at Atchison was then given the executive committee of the committee of forty. The executive committee sent a subcommittee to Leavenworth to try to interest Mr. Carr again, as he had become rather discouraged on account of the bad showing made by existing records and the lack of authentic reports in other cases. Mr. Carr was induced to visit Atchison again, and he then advised the formation of a stock company for the purpose of prospecting for coal, and mining it, should it be found.

In accordance with this suggestion a company was organized, July 19, 1899, under the name of "The Atchison Mining Company, Limited," of which company the writer was elected secretary. The directors, with the assistance of the committee of forty, raised about \$3000 by subscription among the citizens of Atchison. Then the subject dragged for some time. The directors had agreed not to commence operations until they had sufficient money in bank to meet all expenses.

Professor Haworth, of the state university, was then requested to visit Atchi-

son and make a geological survey of the vicinity, in the hope that his report would be favorable and arouse new enthusiasm. This Professor Haworth did, and the report which he sent to Wm. F. Dolan, president of the company, expressed his belief that no well had as yet entirely penetrated the Cherokee shales at Atchison, and that their lower surface would probably be reached there at from 1200 to 1300 feet. The report summed up the whole matter as follows: "It seems to me that the probabilities of a workable vein of coal underlying Atchison are fairly good."

The directors finally collected the subscriptions, but still lacked sufficient money to pay the price asked by reliable diamond-drill companies for the amount of drilling it was desired to do. Later, one of the drill companies, the Sullivan Machinery Company, of Chicago, took a contract to do some drilling near St. Joseph, Mo., nineteen miles northeast of Atchison, for a lower price than they had asked of the Atchison company. This reduction in price was made, presumably, because the state of Missouri would have considerable drilling to do, as it had a fund to be expended in prospecting, under the conditions that, if the prospecting was successful, the parties interested should bear the entire expense, but if unsuccessful, the state was to bear one-half the expense.

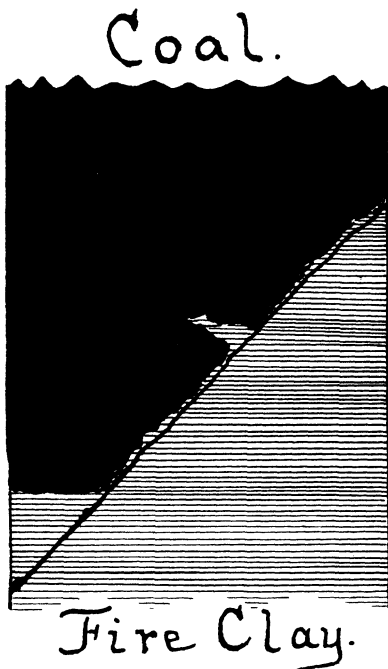
When the directors of the Atchison company learned of this reduction in price, they immediately sent Mayor Donald and S. C. King to see the representatives of the Sullivan Machinery Company, at St. Joseph. The price at which the work was being done there was such that the Atchison company could pay for the actual drilling desired; but they were unwilling to proceed without watchmen, and they did not have sufficient money to pay reliable men for watching at the drill day and night. The reason the Atchison company were unwilling to proceed without watchmen was because there were so many stories to the effect that the correct records of some of the old prospect holes had been suppressed; and it was determined that there should never be any question in regard to the correctness of the record they proposed making.

The writer was then sent to St. Joseph to obtain such geological information as was possible, in order that a comparison might be made of the strata at places near Atchison. A complete copy of the record of the St. Joseph well, as far as it had then gone, was obtained; and this compared so favorably with the known record at Leavenworth, twenty miles southeast of Atchison, that it made the directors still more anxious to proceed with the drilling at Atchison. But as the Atchison company did not have sufficient money to pay watchmen, Professor Haworth was appealed to. He responded by agreeing to send Mr. L. N. Morscher, at the expense of the University Geological Survey, to act as one of these watchmen, the writer to act as the other, and to keep a record of the strata passed through, for the survey. In return, the directors agreed to give the university the entire core from the hole.

As it was thus made possible to finish the hole to a depth of 1000 feet with the money then on hand, a contract was made with the Sullivan Machinery Company to drill a prospect hole at Atchison. It was provided in this contract that the hole should be 1500 feet, if necessary; that a two-inch core should be brought up; that the price of the first 1000 feet should be three dollars per foot; that the price of the next 200 feet should be four dollars per foot, and the price of the next 300 feet should be five dollars per foot; that the Atchison company should furnish fuel and water at the drill; and that there should be on deposit, in the bank, at no time less than the contract price of 100 feet of drilling.

Under this contract work was commenced July 23, 1900. At a depth of 799 feet the Leavenworth seam was found; and when a depth of nearly 1000 feet was

reached, without having penetrated the Coal Measures, the city council voted enough money to go to a depth of 1100 feet. When a depth of 1100 feet was reached some of the directors thought best to discontinue the work, as nothing of value had been found in the last 300 feet, and the foreman in charge of the drill had said it was "burning the people's money" to go further. But, as there was hope of finding coal until the Coal Measures had been entirely penetrated, others of the directors thought best to continue, and money for the next 100 feet was raised.



The Sullivan company, however, at first declined to proceed, as the letter of the contract had not been kept by having the contract price of the next 100 feet of drilling in the bank when the 1100 feet were finished, although this money was put in the bank later on during the same day. This matter was finally adjusted, and it was shown that it was due to a misunderstanding that the Sullivan company thus took advantage of a technicality. In order to prove their good faith, the Sullivan company agreed to drill the balance of the distance through the Coal Measures for three dollars per foot.

Under this agreement the drilling proceeded, and a 36-inch seam of coal was found at a depth of 1123 feet; a 28-inch seam at 1187 feet 9 inches; and a 15-

inch seam at 1197 feet 6 inches; besides many other small seams, as shown by the appended record. By this record it will be seen that the drill penetrated in all eighteen seams of coal, making a total of fourteen feet five inches, of which at least eight feet is probably workable coal. The core of the coal occurring at 879 feet 5 inches is quite remarkable, in that the bottom of it forms an angle of about forty-five degrees. This shows that the drill penetrated this seam, either where a fault occurs or else where there is a horseback; most likely the latter. The above sketch illustrates the appearance of the core.

From the accompanying table, prepared from an analysis of the Atchison coal, made by Mr. E. B. Hayes, of the university, it appears that it is second only to the Cherokee county coal, and as a gas coal is superior to that.

When the Subcarboniferous, or Mississippian limestone, was reached, at 1315 feet, it was thought best by some of the directors to continue to such a depth that there could be no doubt of having entirely penetrated the Coal Measures. The drill, therefore, penetrated the Mississippian limestone for a distance of thirty-eight feet, the core brought up showing it to have the same marked features which characterize it in the extreme southern part of the state, 200 miles away. This correspondence is further shown by an analysis made by Mr. F. B. Porter, a report of which accompanies this paper.

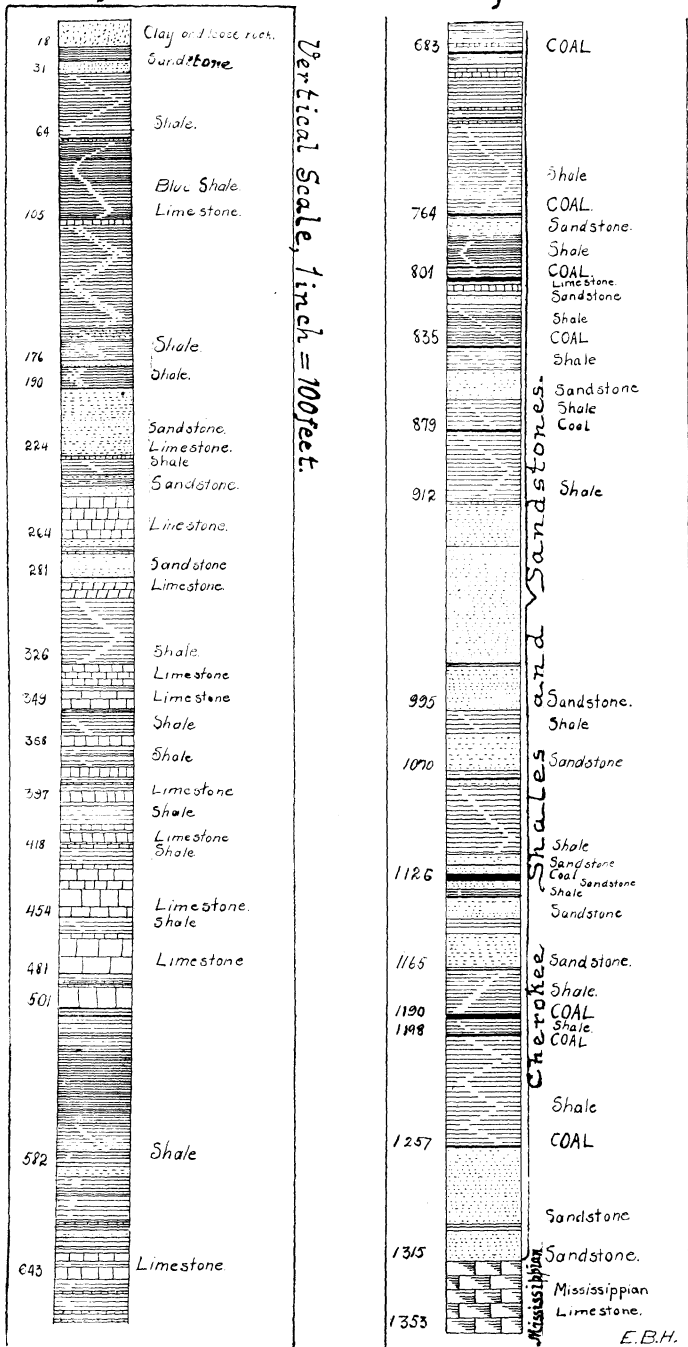
The drilling was completed October 18, 1900, taking nearly three months, an average of one day for each fifteen and one-half feet. The total expenditure by the Atchison company, for all purposes, was about \$4700, or, roughly, \$3.50 per foot.

COMPARATIVE ANALYSES OF COAL FROM DIAMOND-DRILL CORE AT ATCHISON AND COAL FROM WEIR CITY AND LEAVENWORTH.

	Moisture	Volatiles and combustible..	Fixed carbon ..	Total sulphur..	Fixed sulphur..	Volatile sulphur	Iron as Fe ₂ O ₃ ...	Iron as Fe.....	Color of ash....	Form of ash....	Ash.....
Average sample, 36-inch seam, Atchison.....	4.48	41.70	46.89	2.62	.0	2.62	3.06	2.15	Grayish pink...	Light and flaky.....	7.13
Duplicate.....	3.95	42.13	46.51	2.57	.0	2.57	3.06	2.15	"	"	7.11
Average.....	4.21	41.91	46.75	2.59	.0	2.59	3.06	2.15	"	"	7.12
Best sample, 36-inch seam, Atchison.....	2.12	44.82	48.14	1.95	.....	1.95	.....	.....	"	"	4.92
Duplicate.....	2.00	44.30	48.49	1.96	.....	1.96	.....	.....	"	"	5.01
Average.....	2.06	44.56	48.31	1.955	.....	1.955	.....	.....	"	"	4.96
Total average, 36-inch seam, Atchison.....	3.13	43.29	47.53	2.27	.0	2.27	.....	.....	"	"	6.04
Total average, seven samples, Weir City.....	2.85	37.11	54.36	1.35	.44	1.71	.....	.....	.....	.....	5.65
Difference .....	.28	6.18	6.53	.69	.44	.36	.....	.....	.....	.....	.38
Lower sixteen inches of 22-in. seam, Atchison.....	2.89	38.71	43.92	6.33	11	.....	.....	.....	Reddish brown,	Rather coarse and slight clinker,	14.48
Duplicate.....	2.63	39.27	43.69	6.15	10	.....	.....	.....	"	"	14.41
Average.....	2.76	38.99	43.80	6.24	.105	.....	.....	.....	"	"	14.44
Total average, four samples, Leavenworth.....	4.63	36.37	40.66	.....	.....	.....	.....	.....	.....	.....	13.33
Difference	1.57	2.62	3.04	.....	.....	.....	.....	.....	.....	.....	1.11

Total combustible material in total average { of 36-inch seam, Atchison 93.09
of Weir City samples 93.18
Difference..... 0.09

*Vertical Section
of the Atchison Diamond Drill Prospect Hole.*



Log of Atchison deep well, located on Missouri Pacific railroad, two and one-half miles south of Atchison, commenced July 23, 1900. First column of figures shows thickness of strata, in feet and inches; second column shows total depth of hole, in feet and inches.

Clay and loose rock.....	18	18	Black slate.....	7-6	678-6
Clay shale.....	6	24	Limestone.....	1-6	680
Sandstone.....	7	31	Black slate.....	2-4	682-4
Blue shale.....	33	64	COAL.....	0-10	683-2
Sandstone.....	1-2	65-2	Dark shale.....	0-10	684
Blue shale.....	39-10	105	Black shale.....	1	685
Conglomerate.....	2	107	Limy shale.....	2	687
Sand shale.....	53	160	Limestone.....	5	692
Sandstone.....	7	167	Limy shale.....	2	694
Blue shale.....	9	176	Limestone.....	3	697
Sandstone.....	3	179	Dark shale.....	6	703
Sand shale.....	11	190	Clay shale.....	4	707
Sandstone.....	34	224	Limestone.....	1	708
Limestone.....	2	226	Shale mixed with lime.....	4	712
Blue shale.....	8	234	Limestone.....	1	713
Sandstone.....	2	236	Limy shale.....	3	716
Sand shale.....	3	239	Black shale, limestone boulders,	2-6	718-6
Sandstone.....	5	244	Soft, sandy shale.....	4-6	723
Limestone.....	20	264	Blue shale.....	40	763
Sandstone.....	4	268	Hard, black shale.....	0-10	763-10
Limestone.....	1	269	COAL, shale partings.....	0-10	764-8
Sandstone.....	12	281	Sandstone, shale partings.....	10-4	775
Blue shale.....	2	283	Hard, black shale.....	2	777
Limestone.....	8	291	Black shale.....	0-9½	777-9½
Sandy shale.....	35	326	COAL.....	0-2½	778
Limestone.....	11	337	Shale, streaks of sand.....	15	793
Blue shale.....	3	340	Dark shale, limestone bands in it,	6	799
Limestone.....	9	349	COAL.....	1-10	800-10
Blue shale.....	2-8	351-8	Soft shale.....	3-8	804-6
Black shale.....	1-4	353	Lime and shale.....	3-6	808
Limestone.....	1	354	Soft shale.....	2-6	810-6
Blue shale.....	9	363	Sandy shale.....	8-6	819
Limestone.....	5	368	Blue shale, very soft, no core...	4	823
Green shale.....	5	373	Blue shale.....	0-6	823-6
Blue shale.....	5	378	Limestone and shale.....	4-6	828
Limestone.....	5	383	Soft shale.....	2	830
Shale mixed with limestone.....	4	387	Sandy shale.....	3-6	833-6
Limy shale.....	1	388	Black shale.....	1	834-6
Blue shale.....	4	392	COAL.....	1	835-6
Limestone.....	5	397	Sandy shale.....	4-6	840
Black shale.....	2	399	Soft shale.....	3	843
Blue shale.....	9	408	Sandy shale.....	8	851
Limestone.....	3	411	Sandstone.....	9	860
Blue shale.....	1	412	Sandy shale.....	5	865
Conglomerate.....	8	420	Sandstone.....	1	866
Blue shale.....	7	427	Sandy shale.....	4	870
Conglomerate.....	2-6	429-6	Dark shale.....	8-5	878-5
Limestone.....	5-6	435	COAL.....	0-9	879-2
Conglomerate.....	4	439	Soft shale, or fire-clay.....	2-10	882
Limestone.....	15	454	Soft shale, limestone chunks.....	4	886
Blue shale.....	8	462	Sandy shale.....	3	889
Limestone.....	19	481	Limy shale and shale.....	3	892
Black shale.....	4	485	Sandstone.....	11	903
Limestone.....	16-6	501-6	Sandy shale.....	6	909
Blue shale.....	1	502-6	Sandstone, shale partings.....	49	958
Sandy shale.....	5-6	508	Sandstone.....	38	996
Sandstone.....	5	513	COAL.....	0-1	996-1
COAL.....	0-1	513-1	Shale and limestone.....	0-5	996-6
Sandy shale.....	5-11	519	Sandstone.....	23-6	1020
Limestone.....	1	520	Shale.....	3	1023
Sandy shale.....	42	562	Sand shale.....	27	1050
Clay shale.....	15	577	Sandstone, coal partings.....	20	1070
Blue shale.....	7	584	Clay shale.....	1	1071
Sandstone.....	5	589	Sandy shale.....	3	1074
Clay shale.....	24-6	613-6	COAL.....	0-2½	1074-2½
Limestone.....	0-6	614	Dark sandstone.....	1-9½	1076
Clay shale.....	4	618	Sand shale.....	10	1086
Sandstone.....	4	622	Shale, sandstone partings.....	18	1104
Blue shale.....	2	624	Sandstone, shale partings.....	15	1119
Clay shale.....	3-6	627-6	Black shale.....	0-10	1119-10
COAL, slaty.....	0-3	627-9	COAL.....	0-1	1119-11
Black shale, limestone bands.....	1-3	629	Shaly sandstone.....	3-1	1123
Soft shale, or fire-clay.....	2	631	Sandstone and lime.....	0-6	1123-6
Limestone.....	4	635	COAL.....	3	1126-6
Shale, limestone bands.....	8	643	Hard sand, with lime in it.....	3	1130
Blue shale.....	6	649	Dark-blue shale.....	3-9	1133-9
Shale mixed with lime.....	2	651	COAL.....	0-6	1134-3
Blue shale.....	2	653	Sandstone, shale partings.....	10-9	1145
Shale, lime bands.....	5	658	Dark shale.....	7	1152
Soft clay shale.....	2	660	COAL.....	0-4	1152-4
Limestone.....	2	662	Sand and limestone.....	3-8	1158
Sandy shale.....	9	671	Sandstone, shale partings.....	10	1166

Black shale.....	0-6	1166-6	Dark, sandy shale.....	28	1248
COAL.....	0-2	1166-8	Dark, sticky shale.....	8-8	1256-6
Dark-blue shale.....	3-4	1170	COAL.....	0-11	1257-5
Hard, black shale.....	5	1175	Sandstone.....	0-1	1257-6
Hard, dark shale, lime in it....	2	1177	Sandstone, shale partings.....	9-6	1267
Hard, black, laminated shale....	10-9	1187-9	Sandstone, dark partings.....	20	1287
COAL.....	2-4	1190-1	Sandstone, shale partings.....	10	1297
Dark shale.....	0-11	1191	Hard, black shale.....	2	1299
Dark slate.....	6-6	1197-6	White sandstone.....	8	1307
COAL.....	1-3	1198-9	Sandstone.....	8	1315
Dark slate.....	2-3	1201	Limestone.....	38	1353
Dark shale.....	19	1220			

ANALYSES OF THE MISSISSIPPIAN (SUBCARBONIFEROUS)
LIMESTONE FROM THE ATCHISON PROSPECT WELL.

BY FRED B. PORTER, LAWRENCE.

Read before the Academy, at Topeka, December 29, 1900.

After the core of the diamond-drill prospect well at Atchison was brought to the University of Kansas, two samples of the lowest strata reached by the well were analyzed in the quantitative chemical laboratory, under the direction of Prof. Edward Bartow. A sample from a point twenty-six feet from the bottom and 1124 feet below the surface was analyzed by Maud Hodgdon, and a second sample, from the last six inches of the core, was analyzed by N. L. Stewart and the writer.

The results of the analyses are as follows:

	No. 1. Hodgdon.	No. 2. Stewart.	No. 3. Porter.
Silicious matter.....	2.34	.....	3.63
Silica (SiO ₂).....	.....	2.27*	.....
Iron oxid (Fe ₂ O ₃).....	.....	.49*	.....
Aluminum oxid (Al ₂ O ₃).....	.65	.34*	.36
Calcium oxid (CaO).....	52.98	52.45*	53.11
Magnesium oxid (MgO).....	.52	.72	.48
Carbon dioxid (CO ₂), calculated for CaO and MgO..	42.16	42.02*	42.29*
Carbon dioxid, determined..... (.....)	(.....)	(42.41)	(42.15)
Moisture (H ₂ O).....	.08	.14	.09
Totals.....	98.73	98.43	99.96

The analyses marked (*) are from single determinations; the remainder, from an average of two or more.

A hypothetical combination of the above constituents is as follows:

	No. 1.	No. 2.	No. 3.	Galena.
Silicious matter, or SiO ₂	2.34	2.27	3.63	1.00
Iron and aluminum oxids.....	.65	.83	.36	.69
Calcium carbonate (CaCO ₃).....	94.58	93.68	94.84	97.32
Magnesium carbonate (MgCO ₃).....	1.08	1.51	1.04	.80
Water (H ₂ O).....	.08	.14	.09	.....
Totals.....	98.73	98.43	99.96	99.81

Column 4 gives an analysis of the Subcarboniferous from Galena, recorded in the United States Geological Survey for 1894, part IV, page 505, and shows the relation of composition of the same strata in two localities.